KNOWLEDGE OF PACKAGING WASTE IN THE CZECH REPUBLIC: A STUDENT'S AWARENESS STUDY

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Abstract
The residential sector generates around 14% of the overall waste production in the Czech Republic. This essential share requires special attention to analyze with particular emphasis on citizen education. Thus, this research is dedicated to citizens' awareness about packaging waste to increase their knowledge. The experiment was conducted in the form of a survey, and the students were asked to estimate the weight of the packaging presented to them. This experiment featured three different groups of students over time. The results did not demonstrate a significant difference between these groups over time. The long-term home study caused by COVID-19 did not appear to have affected students' knowledge of packaging waste. Further, each group was compared to the actual weight value and evaluated. This study showed students' actual knowledge about packaging waste and highlighted the gap and importance of education in waste management.

Key words: *municipal waste; estimation; packaging waste.*

INTRODUCTION

The rapid growth of waste is a constant reminder to European Union to effectively manage with it in order to minimize their environmental impact. Packaging waste is one of the most critical environmental issues due to its big volume, reusability, and recyclability (*Han et al., 2010*). The process of a suitable treatment of every type of waste starts at its generation site, in case of municipal waste, it is the household. There are several factors that might have a direct impact on the amount of waste produced by families, e.i. higher incomes, urbanization dynamics, changing in lifestyles and consumption patterns, smaller households *(Monavari et al., 2012; Tencati et al., 2016*), but social awareness and environmental education level, among others, are two of the factors that can play a role on sorting and recycling rate (*Suthar and Singh, 2015*). Thus, this research is dedicated to one of those indicators - the awareness of citizens about packaging waste. Source separation waste collection systems are essential to increase resource efficiency, achieve European recycling goals, and achieve a circular economy *(Tallentire and Steubing, 2020*).

This aim of this study was to analyse students' awareness and knowledge about packaging waste generated at home over a medium-long period. We consider time as an important factor which can change the view of people on waste generation at source, therefore this study was repeated. COVID-19 causes a wide home office and can also change the awareness of people and their view on waste production at home.

MATERIALS AND METHODS

This experiment focuses on the awareness of citizens about different types of waste. Three different groups of students from a university in Prague, Czech Republic, participated in this study. Nine types of packaging waste were used in this experiment. Approximately 90 students participated in this experiment; they were given the task of guessing the weight of prepared samples stated in Tab. 1. This experiment lasted several years to capture changes in perception about packaging waste over time and to include the impact of COVID-19 on citizens. Estimates from all years and groups were collected and analyzed. The comparison was conducted within groups as well as each group to the real weight value. Due to the fact, that not all data showed a normal distribution, the non-parametric method of statistics was applied for data without normal distribution. Kruskal-Wallis test (*Kruskal and Wallis, 1952*) was applied for assessing the difference among three student groups. The Student's t-test and its non-parametric equivalent Wilcoxon signed-rank test (*Wilcoxon, 1945*) were used for evaluating the difference between each group and the real value.

Tab. 1 List of packaging waste used in the experiment

Packaging waste	PET 2l	Plastic bottle 1.5 l	Plastic bottle 0.5 l	Can 0.5 l	Milk carton 1 l	Juice carton 1 l	Champagne 0.75 l	Wine 0.75 l	Beer PET 1.5 l
Weight (g)	56	37	24	15	30	38	611	420	47

RESULTS AND DISCUSSION

This study had the objective of assessing the awareness of packaging waste among students at university. Also during the same time frame, the COVID-19 has emerged and left certain impact on students. The form of study switched to online environment and students spent more time at home. Therefore, we collected data from a group of students in 2022, about two years after COVID-19 first appeared in the Czech Republic and compared them to groups of students from before the coronavirus spread. Furthermore, we assessed each group separately and compared their estimation to the real value.

The result of comparing among groups has shown, that there is no significant difference between assessed groups in the time period (Fig. 1). P value of comparison of each group was all out of critical region (p value > 0,05), this results in a fact that fails to reject the null hypothesis. So it suggested that there is no significant difference between surveyed groups over time. This is related to the fact that COVID-19 and home studying appear not to have had an impact on the perception and knowledge of students about waste packaging even students have stayed at home for a long time and the waste composition has changed during this season.

Then we compared each group of students separately with the real value of the packaging weight to test how they performed (Fig. 2 and 3). The summary of statistical result can be found in Tab. 2. Most of the data did not have the normal distribution, therefore non-parametric method of Student's t-test was chosen. Data with a normal distribution were tested using the parametric Student's t-test and marked in grey and p values above the threshold of significance are marked in bold (without significance). The most accurate students came from both groups A and C, who succeeded in 6 different types of packaging weight where their estimation was close to the real value. Group B has only one correct estimate less than others, but it still has more than half of the accurate estimates. All three groups had a good estimate when guessing the weight of the 1.5-liter plastic bottle, as well as the milk carton and the wine glass. The most difficult packaging type for students was 2-liter PET, which did not meet success in any of the three groups. Across all groups, the average estimate was higher than the actual level. A similar situation occurred with champagne glasses when the average estimate was higher than the actual weight. On the other hand, students in three groups estimated plastic beer bottles to be lighter than they actually were. The possible reason might be that PET is a special plastic type and has a different weight than other types of plastic bottles, therefore, even students were successful in both sizes of plastic bottles (0.5 l and 1.5 l), but failed in 2-liter PET. Also the reason might be the unusual size of the PET bottle (2 l), which is not used by students very often. The same reason is suitable for cans with 0.5 l of volume; this type of packaging is very rarely used for beverages.

The summary demonstrates that students at university have common knowledge and do not differ through grades. However, the university must continue to encourage via education and awareness on managing the municipal waste including packaging waste. This is important according to (*Hines et al., 1987*) which suggests that a person's knowledge and awareness, and sense of responsibility influence the amount of consistency between attitude and action toward the environment. Not only students at universities, it is necessary to promote awareness and draw attention to the necessity of recycling materials already among the younger generations (*Licy et al., 2013*).

Tab. 2 Summary of p-values of the statistical analysis. Each group was compared to the real value of packaging weight.

Group	PET 2l	Plastic bottle 1.5 l	Plastic bottle 0.5 l	Can 0.5 l	Milk carton 1 l	Juice carton 1 l	Champa-gne 0.75 l	Wine 0.75 l	Beer PET 1.5 l
A	0.0125	0.3764	0.5338	0.0562	0.1310	0.3012	0.0008	0.1030	0.0008
B	0.0285	0.1433	0.0243	0.0188	0.4712	0.3271	0.4864	0.7981	$1.39E^{-07}$
C	0.0055	0.9795	0.7678	$3.57E^{-05}$	0.0791	0.2024	0.0094	0.6344	0.5440

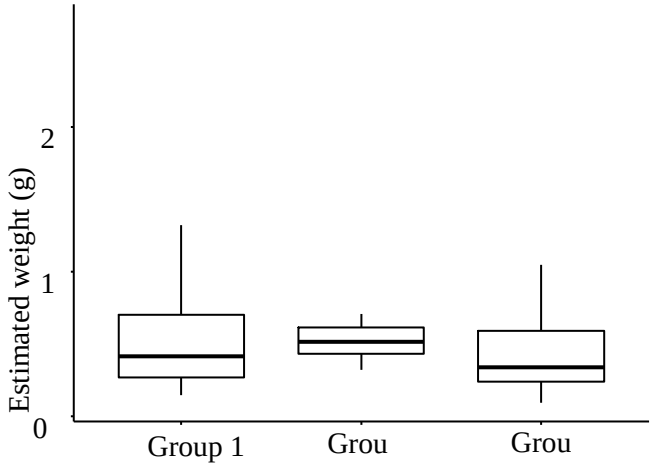

Fig. 1 Comparing means withing groups of students.

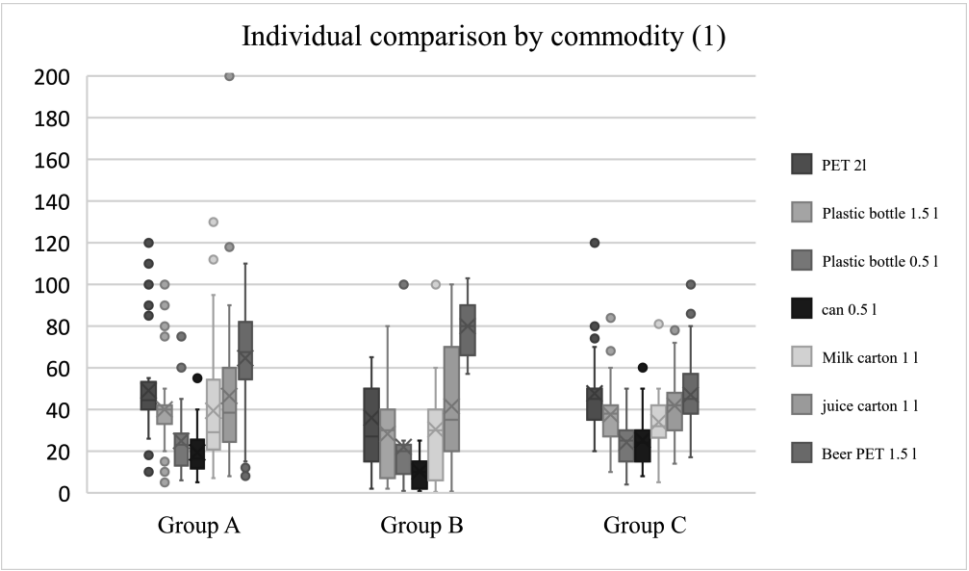

Fig. 2 A more detailed look at the comparison between groups by type of packaging waste type.

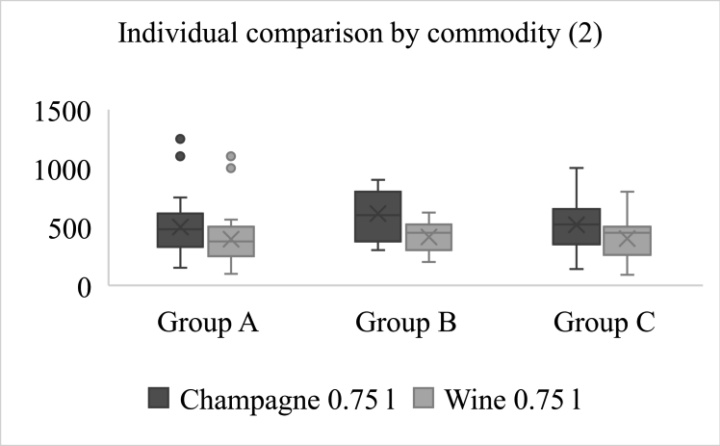

Fig. 3 Comparison between groups separated from the overall data.

CONCLUSIONS

In this study, an application of knowledge testing method is presented. The experiment showed the actual knowledge of students about packaging waste and pointed out the gap and importance of education in waste management. Further, it is suggested to perform this experiment at other educational levels in order to obtain a more thorough and comprehensive evaluation of all age groups.

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